Optimization of mitigation mussel culture for nutrient extraction and animal feedstock replacement: An introduction.

Taylor, Daniel; Saurel, Camille; Nielsen, Pernille; Petersen, Jens Kjerulf

Publication date:
2017

Document Version
Publisher's PDF, also known as Version of record

Citation (APA):
Taylor, D., Saurel, C., Nielsen, P., & Petersen, J. K. (2017). *Optimization of mitigation mussel culture for nutrient extraction and animal feedstock replacement: An introduction.*. Abstract from European Aquaculture Society Meeting 2017, Dubrovnik, Croatia.

OPTIMIZATION OF MITIGATION MUSSEL CULTURE FOR NUTRIENT EXTRACTION AND ANIMAL FEEDSTOCK REPLACEMENT: AN INTRODUCTION

D. Taylor*, C. Saurel, P. Nielsen, J. Kjerulf Petersen

Danish Shellfish Centre, DTU Aqua, 7900 Nykøbing Mors, Denmark
E-Mail: dtay@aqua.dtu.dk

Background

Enhancement of environmental quality of coastal waters impacted by point and diffuse nutrient sources is increasingly recognized as a globally established objective to restore and increase resiliency of coastal ecosystems to the advantage of coastal communities, and is a key part of the EU Water Framework Directive (Borja 2005). Highly enriched aquatic environments experience ecological instability, requiring synergistic mitigative mechanisms for nutrient reduction that are economically tenable. These mechanisms are principally manifested through nutrient management programs that reduce or increase efficiency in nutrient application, or enhance nutrient sinks (Paerl 2009). Bivalve culture has been advocated as a means to mitigate eutrophic conditions through top-down biofiltration control of primary production and enhancement of biogeochemical cycling (Ferreira and Bricker 2016; Petersen et al. 2016; Rose et al. 2014). While traditional mussel culture has focused on human food product quality with secondary nutrient extractive impacts, cultivation techniques maximizing nutrient extraction (i.e. mussel biomass) exhibit intriguing potential in terms of remediating coastal water quality (Nielsen et al. 2016). This type of culture, Mitigation Mussel Culture (MMC), emphasizes reduced grow-out periods, minimizing operational costs, and strategic deployment. Given the complex conditions in which to assess potential for MMC techniques at reducing nutrient loading, the status of scientific consensus on the ecological contributions of intensive mussel culture is not resolved (Petersen et al. 2012; Rose et al. 2012; Stadmark and Conley 2011). This is particularly relevant to contemporary science as there is a paucity of commercial-scale experimentation of mitigation bivalve culture, where systemic complexity can be observed (Petersen et al. 2016).

Biomass harvested through this type of extractive culture technique demonstrates potential to return nutrients back to the land and into other food systems in the form of high quality protein and lipid source in animal feeds (Afrose et al. 2016; Jönsson and Elwinger 2009; Larsen et al. 2013). Fishmeal has historically been an important protein in animal feeds provided its balanced amino acid profile and high digestibility, yet its supply has stalled relative to demand from burgeoning animal production; particularly finfish and penaeid aquaculture (Olsen and Hasan 2012). While many carefully formulated fishmeal and fish oil-reduced diets have shown promise, higher replacement levels may also require synthetic essential amino acid (EAA) supplementation or contribute to alterations in fatty acid metabolism and diminished composition of the finished product. Concurrently, the expansion of organic animal production requires sources of sustainable marine proteins and lipids, while the use of fishmeal is becoming increasingly limited in this market. The conversion of a water quality ailment to a natural high-quality feed source fulfills multiple simultaneous objectives in sustainable food production and coastal management.

Study Outline

Mitigation Mussel Culture will be introduced conceptually, as well as the means by which its efficacy will be evaluated. Multiple ongoing experiments assessing 1) cultivation practices maximizing biomass yield, 2) benthic impacts of MMC, 3) seston depletion effects, and 4) differential biochemical compositions of MMC between separate eutrophied water bodies will be described and initial data points will be presented. Integration of MMC themes through physical and Dynamic Energy Budget modeling efforts will presented in a detailed framework, as well as tools to be developed for investigating future expansion.

References

Afrose, Sadia et al. 2016. "Influence of Blue Mussel (Mytilus Edulis) and Starfish (Asterias Rubens) Meals on Production Performance, Egg Quality and Apparent Total Tract Digestibility of Nutrients of Laying Hens." *Animal Feed Science and Technology* 213: 108–17. http://www.sciencedirect.com.proxy.findit.dtu.dk/science/article/pii/S0377840116300086 (May 18, 2017).

Borja, Ángel. 2005. "The European Water Framework Directive: A Challenge for Nearshore, Coastal and Continental Shelf Research." *Continental Shelf Research* 25(14): 1768–83. http://www.sciencedirect.com/science/article/pii/S0278434305001068 (May 22, 2017).

Ferreira, J. G., and S. B. Bricker. 2016. "Goods and Services of Extensive Aquaculture: Shellfish Culture and Nutrient Trading." *Aquaculture International* 24(3): 803–25.

Jönsson, L, and K Elwinger. 2009. "Mussel Meal as a Replacement for Fish Meal in Feeds for Organic Poultry – a Pilot Short-Term Study." *Acta Agriculturae Scandinavica, Section A — Animal Science* 59(1): 22–27. http://dx.doi.org/10.1080/09064700902730158.

Larsen, Bodil Katrine et al. 2013. "Nutritional Value of Mussel Meal in Fish Feed: A Sustainable, High-Quality Protein Source."

Nielsen, Pernille, P J Cranford, M Maar, and Jens Kjerulf Petersen. 2016. "Magnitude, Spatial Scale and Optimization of Ecosystem Services from a Nutrient Extraction Mussel Farm in the Eutrophic Skive Fjord, Denmark." *Aquaculture Environment Interactions* 8: 311–29.

Olsen, Ragnar L., and Mohammad R. Hasan. 2012. "A Limited Supply of Fishmeal: Impact on Future Increases in Global Aquaculture Production." *Trends in Food Science & Technology* 27(2): 120–28. http://www.sciencedirect.com/science/article/pii/S0924224412001197 (May 18, 2017).

Paerl, Hans W. 2009. "Controlling Eutrophication along the Freshwater-Marine Continuum: Dual Nutrient (N and P) Reductions Are Essential." *Estuaries and Coasts* 32(4): 593–601.

Petersen, Jens Kjerulf et al. 2012. "Mussel Farming Can Be Used as a Mitigation Tool – A Reply." *Marine Pollution Bulletin* 64(2): 452–54. http://www.sciencedirect.com/science/article/pii/S0025326X11006199 (May 18, 2017).

Petersen, Jens Kjerulf, Camille Saurel, Pernille Nielsen, and Karen Timmermann. 2016. "The Use of Shellfish for Eutrophication Control." *Aquaculture International* 24(3): 857–78.

Rose, Julie M. et al. 2012. "Comment on Stadmark and Conley (2011) 'Mussel Farming as a Nutrient Reduction Measure in the Baltic Sea: Consideration of Nutrient Biogeochemical Cycles.'" *Marine Pollution Bulletin* 64(2): 449–51. http://www.sciencedirect.com/science/article/pii/S0025326X11006163 (May 18, 2017).

Rose, Julie M., Suzanne B. Bricker, Mark A. Tedesco, and Gary H. Wikfors. 2014. "A Role for Shellfish Aquaculture in Coastal Nitrogen Management." *Environmental Science and Technology* 48(5): 2519–25.

Stadmark, J., and D. J. Conley. 2011. "Mussel Farming as a Nutrient Reduction Measure in the Baltic Sea: Consideration of Nutrient Biogeochemical Cycles." *Marine Pollution Bulletin* 62(7): 1385–88.